

# Acid Rain

## What is Acid Rain?

Acid rain is a result of air pollution. When any type of fuel is burnt, lots of different chemicals are produced. The smoke that comes from a fire or the fumes that come out of a car exhaust don't just contain the sooty grey particles that you can see - they also contains lots of invisible gases that can be even more harmful to our environment.

Power stations, factories and cars all burn fuels and therefore they all produce polluting gases. Some of these gases (especially nitrogen oxides and sulphur dioxide) react with the tiny droplets of water in clouds to form sulphuric and nitric acids. The rain from these clouds then falls as very weak acid - which is why it is known as "acid rain".

## How acidic is acid rain?

Acidity is measured using a scale called the pH scale. This scale goes from 0 to 14. 0 is the most acidic and 14 is the most alkaline (opposite of acidic). Something with a pH value of 7, we call neutral, this means that it is neither acidic nor alkaline.

Very strong acids will burn if they touch your skin and can even destroy metals. Acid rain is much, much weaker than this, never acidic enough to burn your skin.

Rain is always slightly acidic because it mixes with naturally occurring oxides in the air. Unpolluted rain would have a pH value of between 5 and 6. When the air becomes more polluted with nitrogen oxides and sulphur dioxide the acidity can increase to a pH value of 4. Some rain has even been recorded as being pH2.

Vinegar has a pH value of 2.2 and lemon juice has a value of pH2.3. Even the strongest recorded acid rain is only about as acidic as lemon juice or vinegar and we know that these don't harm us - so why do we worry about acid rain?

## The Effects of Acid Rain

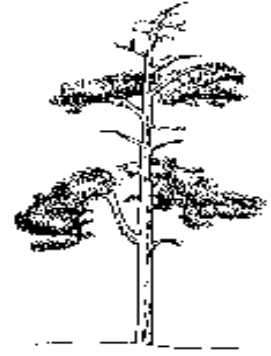
Acid rain can be carried great distances in the atmosphere, not just between countries but also from continent to continent. The acid can also take the form of snow, mists and dry dusts. The rain sometimes falls many miles from the source of pollution but wherever it falls it can have a serious effect on soil, trees, buildings and water.

Forests all over the world are dying, fish are dying. In Scandinavia there are dead lakes, which are crystal clear and contain no living creatures or plant life. Many of Britain's freshwater fish are threatened; there have been reports of deformed fish being hatched. This leads to fish-eating birds and animals being affected also. Is acid rain responsible for all this? Scientists have been doing a lot of research into how acid rain affects the environment.

## Forests

It is thought that acid rain can cause trees to grow more slowly or even to die but scientists have found that it is not the only cause. The same amount of acid rain seems to have more effect in some areas than it does in others.

As acid rain falls on a forest it trickles through the leaves of the trees and runs down into the soil below. Some of it finds its way into streams and then on into rivers and lakes. Some types of soil can help to neutralize the acid - they have what is called a "buffering capacity".



Other soils are already slightly acidic and these are particularly susceptible to the effects of acid rain.

Acid rain can affect trees in several different ways, it may:

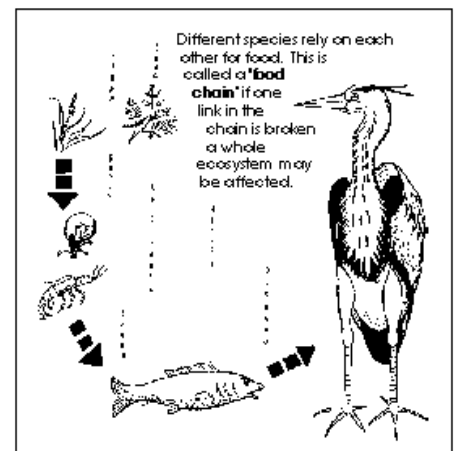
- dissolve and wash away the nutrients and minerals in the soil which help the trees to grow.
- cause the release of harmful substances such as aluminium into the soil.
- wear away the waxy protective coating of leaves, damaging them and preventing them from being able to photosynthesis properly.

A combination of these effects weakens the trees which mean that they can be more easily attacked by diseases and insects or injured by bad weather. It is not just trees that are affected by acid rain, other plants may also suffer.

## Lakes and Rivers

It is in aquatic habitats that the effects of acid rain are most obvious. Acid rain runs off the land and ends up in streams, lakes and marshes - the rain also falls directly on these areas.

As the acidity of a lake increases, the water becomes clearer and the numbers of fish and other water animals decline. Some species of plant and animal are better able to survive in acidic water than others. Freshwater shrimps, snails, mussels are the most quickly affected by acidification followed by fish such as minnows, salmon and roach. The roe and fry (eggs and young) of the fish are the worst affected, the acidity of the water can cause deformity in young fish and can prevent eggs from hatching properly.



The acidity of the water does not just affect species directly; it also causes toxic substances like aluminium to be released into the water from the soil, harming fish and other aquatic animals.

Lakes, rivers and marshes each have their own fragile ecosystem with many different species of plants and animals all depending on one another to survive. If a species of fish disappears, the animals which feed on it will gradually disappear too. If the extinct fish used to feed on a particular species of large insect, that insect population will start to grow, this in turn will affect the smaller insects or plankton on which the larger insect feeds.

## **Buildings**

Every type of material will become eroded sooner or later by the effects of the climate. Water, wind, ice and snow all help in the erosion process but unfortunately; acid rain can help to make this natural process even quicker. Statues, buildings, vehicles, pipes and cables can all suffer. The worst affected are things made from limestone or sandstone as these types of rock are particularly susceptible and can be affected by air pollution in gaseous form as well as by acid rain.

## **Where is it coming from?**

Until relatively recently air pollution has been seen as a local issue. It was in southern Scandinavia in the late 1950's that the problems of acid rain were first observed and it was then that people began to realize that the origins of this pollution were far away in Britain and Northern Europe. One early answer to industrial air pollution was to build very tall chimneys. Unfortunately all this does is push the polluting gases up into the clouds allowing emissions to float away on the wind. The wind carries the pollution many hundreds of miles away where it eventually falls as acid rain. In this way Britain has contributed at least 16% of the acid deposition in Norway. Over ninety percent of Norway's acid pollution comes from other countries. The worst European polluters are Germany, UK, Poland and Spain, each of them producing over a million tons of sulphur emissions in 1994. Governments are now beginning to admit that acid rain is a serious environmental problem and many countries are now taking steps to reduce the amount of sulphur and nitrogen emissions.

## **What can be done?**

Reduce emissions:

- Burning fossil fuels is still one of the cheapest ways to produce electricity so people are now researching new ways to burn fuel which don't produce so much pollution.
- Governments need to spend more money on pollution control even if it does mean an increase in the price of electricity.
- Sulphur can also be 'washed' out of smoke by spraying a mixture of water and powdered limestone into the smokestack.
- Cars are now fitted with catalytic converters which remove three dangerous chemicals from exhaust gases.

## **Find alternative sources of energy**

- Governments need to invest in researching different ways to produce energy.
- Two other sources that are currently used are hydroelectric and nuclear power. These are 'clean' as far as acid rain goes but what other impact do they have on our environment?
- Other sources could be solar energy or windmills but how reliable would these be in places where it is not very windy or sunny?
- All energy sources have different benefits and costs and all these have to be weighed up before any government decides which of them it is going to use.

## Conserving Resources

- Greater subsidies of public transport by the government to encourage people to use public transport rather than always travelling by car.



- Every individual can make an effort to save energy by switching off lights when they are not being used and using energy-saving appliances - when less electricity is being used, pollution from power plants decreases.

- Walking, cycling and sharing cars all reduce the pollution from vehicles

## Restoring the Damage done by Acid Rain

Lakes and rivers can have powdered limestone added to them to neutralize the water - this is called "liming". Liming, however, is expensive and its effects are only temporary - it needs to be continued until the acid rain stops. The people of Norway and Sweden have successfully used liming to help restore lakes and streams in their countries. A major liming programme is currently taking place in Wales.

The greenhouse effect is the rise in temperature that the Earth experiences because certain gases in the atmosphere (water vapor, carbon dioxide, nitrous oxide, and methane, for example) trap energy from the sun. Without these gases, heat would escape back into space and Earth's average temperature would be about 60°F colder. Because of how they warm our world, these gases are referred to as greenhouse gases

Have you ever seen a greenhouse? Most greenhouses look like a small glass house. Greenhouses are used to grow plants, especially in the winter. Greenhouses work by trapping heat from the sun. The glass panels of the greenhouse let in light but keep heat from escaping. This causes the greenhouse to heat up, much like the inside of a car parked in sunlight, and keeps the plants warm enough to live in the winter.



The Earth's atmosphere is all around us. It is the air that we breathe. Greenhouse gases in the atmosphere behave much like the glass panes in a greenhouse. Sunlight enters the Earth's atmosphere, passing through the blanket of greenhouse gases. As it reaches the Earth's surface, land, water, and biosphere absorb the sunlight's energy. Once absorbed, this energy is sent back into the atmosphere. Some of the energy passes back into space, but much of it remains trapped in the atmosphere by the greenhouse gases, causing our world to heat up.

The greenhouse effect is important. Without the greenhouse effect, the Earth would not be warm enough for humans to live. But if the greenhouse effect becomes stronger, it could make the Earth warmer than usual. Even a little extra warming may cause problems for humans, plants, and animals.

# What is the Climate System?

It may seem hard to believe that people can actually change the Earth's climate. But scientists think that the things people do that send greenhouse gases into the air are making our planet warmer.

## Atmosphere

The atmosphere covers the Earth. It is a thin layer of mixed gases which make up the air we breathe. This thin layer also helps the Earth from becoming too hot or too cold, much like clothing does for us. Weather systems, which develop in the lower atmosphere, are driven by heat from the sun, the rotation of the Earth, and variations in the Earth's surface.

## Oceans

Oceans cover about 70 percent of Earth's surface. Their large mass and thermal properties enable them to store vast quantities of heat. Oceans buffer and regulate temperature – energy absorbed or lost by the oceans results in a smaller surface temperature change than would occur over land. The atmosphere and ocean constantly exchange energy and matter. For example, water evaporates from the oceans into the atmosphere. This moisture then falls back to the Earth as precipitation – rain, snow, sleet, and even the morning dew on the grass.

## Land

Land covers 27 percent of Earth's surface, and land topography influences weather patterns. For example, the weather in areas covered by mountains can be completely different than the weather in areas where the land is mostly flat.

## Ice

Ice is the world's largest supply of freshwater. It covers the remaining 3 percent of Earth's surface including most of Antarctica and Greenland. Because ice is highly reflective and because of its insulating properties, ice plays an important role in regulating climate.

## Biosphere

The biosphere is that part of Earth's atmosphere, land, oceans that supports any living plant, animal, or organism. It is the place where plants and animals, including humans, live. Large quantities of carbon dioxide are exchanged between the land-based biosphere and the atmosphere as plants take in carbon dioxide and give off oxygen, and animals inhale oxygen and exhale carbon dioxide.

## The Greenhouse Effect

